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Indications of Geometrical Tolerances on Drawings

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JAPANESE INDUSTRIAL STANDARD J I S

Indications of Geometrical Tolerances on Drawings

B 0021-1984
(Reaffirmed: 1994)

1. Scope

This Japanese Industrial Standard specifies the methods of symbolical expression and diagrammatical indication of tolerances of form, orientation, location, and run-out of considered objects, hereinafter referred to generally as the "geometrical tolerances", or simply as the "tolerances" in the case where it is not liable to be confounded, on technical drawings.

2. Definition

The main terms used in this standard shall mean as follows except as specified in JIS B 0022 and JIS B 0621.

(1) geometrical tolerance The allowable value of geometrical deviation.

Remark: For the definition at geometrical deviations and the method of their indication, refer to JIS B 0621.

Applicable Standards:

JIS B 0001-Drawing Practice for Mechanical Engineering

JIS B 0022-Datums and Datum-systems for Geometrical Tolerances

JIS B 0023-Maximum Material Principle

JIS B 0621-Definitions and Designations of Geometrical Deviations

Corresponding International Standard:

ISO/DIS 1101 – Technical drawings–Geometrical tolerancing–Tolerances of form, orientation, location and run-out–Generalities, definitions, symbols, indications on drawings

Reference Standards:

ISO 1101/II – Technical drawings–Tolerances of form and of position–Part II: Maximum material principle

ISO 5459 – Technical drawings-Geometrical tolerancing–Datums and datum-systems for geometrical tolerances

ISO 7083 – Technical drawings–Symbols for geometrical tolerancing–Proportions and dimensions

(2) tolerance zone In a feature controlled by geometrical tolerance, hereinafter referred to as the "toleranced feature", the zone within which the feature is allowed to deviate from its geometrically exact form, orientation, or location.

3. General Rules

The general rules applied where geometrical tolerances are specified shall be as follows:

(1) The allowable values of deviation and run-out of the form, orientation, and location of the considered object specified on drawings shall, as a rule, be diagrammatically indicated by geometrical tolerances.

(2) The allowable dimensional limits specified for a feature shall not control the geometrical tolerance unless otherwise specified.

(3) The geometrical tolerances shall be specified for indispensable parts based on the functional requirements, interchangeability, and the like.

(4) The indication of geometrical tolerances shall not restrict the application of any particular method of production, measurement, or inspection. However, where restriction to a specific method is required, it shall be specified separately.

Remark: Where a particular method of measurement or inspection is not separately specified, any method of measurement or inspection may be selected if it conforms to the definition of the tolerance zone being considered.

4. Kinds and Symbols of Geometrical Tolerances

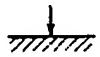
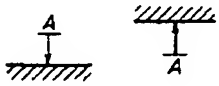
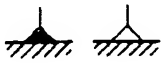
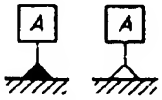
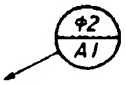
The kinds and symbols of geometrical tolerances shall be as shown in Table 1.

The additional symbols used with geometrical tolerances shall be as shown in Table 2.

Table 1. Kinds and Symbols of Geometrical Tolerances

Applicable feature	Kind of tolerance		Symbol	Remark
Single features	Form tolerance	Straightness tolerance	—	Refer to 1. of Attached Table
		Flatness tolerance	▱	Refer to 2. of Attached Table
		Circularity tolerance	○	Refer to 3. of Attached Table
		Cylindricity tolerance	⌭	Refer to 4. of Attached Table
Single or related features		Profile tolerance of line	⌒	Refer to 5. of Attached Table
		Profile tolerance of surface	⌓	Refer to 6. of Attached Table
Related features	Orientation tolerance	Parallelism tolerance	//	Refer to 7. of Attached Table
		Perpendicularity tolerance	⊥	Refer to 8. of Attached Table
		Angularity tolerance	∠	Refer to 9. of Attached Table
	Location tolerance	Positional tolerance	⌖	Refer to 10. of Attached Table
		Coaxiality or concentricity tolerance	◎	Refer to 11. of Attached Table
		Symmetry tolerance	⌯	Refer to 12. of Attached Table
	Run-out tolerance	Circular run-out tolerance	↗	Refer to 13. of Attached Table
		Total run-out tolerance	⌰	Refer to 14. of Attached Table

Table 2. Additional Symbols

Content to be indicated		Symbol ([1])	Remark (clause or standard)
Toleranced feature	In the case of direct indication		6.3
	In the case of indication by letter symbol		6.3 (4)
Datum	In the case of direct indication		8.2 (4)
	In the case of indication by letter symbol		8.2
Datum target frame			JIS B 0022
Theoretically exact dimension			10.
Projected tolerance zone			11.
Maximum material principle			12.

Note ([1]) The letter symbols and numerical values in the symbol column are shown as examples except for P and M.

5. General Rules on Tolerance Zone

The tolerance zones in which toleranced features must be contained shall be as follows:

(1) The geometrical tolerance applied to a feature (point, line, axis, surface, or median surface) defines the tolerance zone in which that feature should be contained.

(2) According to the kind of tolerance and the method of indicating the tolerance value thereof, the tolerance zone is represented by either one of the tolerance zones shown in Table 3.

Table 3. Tolerance Zones and Tolerance Values

Tolerance zone		Tolerance value	Remark
(1)	Zone within a circle	Diameter of circle	Refer to 10.1 of Attached Table
(2)	Zone between two concentric circles	Difference between radii of concentric circles	Refer to 3. of Attached Table
(3)	Zone defined by two equidistant lines or two parallel straight lines	Distance between two lines or two straight lines	Refer to 1.2 of Attached Table
(4)	Zone within a sphere	Diameter of sphere	Refer to 10.1 of Attached Table
(5)	Zone within a cylinder	Diameter of cylinder	Refer to 1.3 of Attached Table
(6)	Zone defined by two coaxial cylinders	Difference between radii of coaxial cylinders	Refer to 4. of Attached Table
(7)	Zone defined by two equidistant surfaces or two parallel planes	Distance between two surfaces or two planes	Refer to 1.1 of Attached Table
(8)	Zone within a rectangular parallelepiped	Lengths of respective sides of rectangular parallelepiped	Refer to 1.3 of Attached Table

(3) Where the tolerance zone is a circle or cylinder, the tolerance value is preceded by symbol ϕ (Fig. 3), and where the tolerance zone is a sphere, the tolerance value shall be preceded by symbol Sϕ (refer to the examples of diagrammatical indication in 10.1 of Attached Table).

(4) For a toleranced feature, there are cases in which two or more geometrical tolerances are specified for functional reasons (Fig. 5).

In addition, some geometrical tolerances control other kinds of geometrical deviations at the same time (for example, when parallelism is controlled, it also controls, within its tolerance zone, straightness in the case of a line, and flatness in the case of a surface). Conversely, some geometrical tolerances do not control other kinds of geometrical deviations (for example, straightness tolerance does not control flatness).

(5) Toleranced features may take any form or orientation in their tolerance zones. However, where a restriction is imposed by a supplementary note (Fig. 42 and Fig. 43) or by the specification of a stricter tolerance zone (Fig. 41), such restriction shall be observed.

(6) The specified tolerance is applied to the whole length or whole surface of the considered feature. However, where the range to which that tolerance is to be applied is specified, the specified tolerance should be applied only to that range (Fig. 39 and Fig. 46).

(7) The geometrical tolerance specified for a relative feature does not control the form deviation of the datum feature itself. Therefore, when required, a form tolerance shall be specified for the datum feature.

Remark: It is desirable that the form of the datum feature has a sufficiently small geometrical deviation to meet the purpose as a datum.

6. Method of Diagrammatical Indication of Tolerances

6.1 General Requirements of Diagrammatical Indication The general requirements of diagrammatical indication shall be as follows:

(1) To specify a geometrical tolerance for a single feature, indication shall be made by connecting with a leader line a rectangular frame in which the kind of tolerance and the tolerance value are written, hereinafter referred to as the "tolerance frame", with the feature.

(2) To specify a geometrical tolerance for a related feature, the datum shall be attached with a datum triangle (a right-angled equilateral triangle) and indication shall be made as in (1) by relating the triangle symbol to the tolerance frame (refer to 8).

6.2 Contents Indicated in Tolerance Frame

6.2.1 The contents to be indicated for a tolerance shall be written in the tolerance frame divided into two or more compartments. The following contents shall respectively be written in those compartments from left to right in the sequence of (1), (2), and (3) (Fig. 1, Fig. 2, and Fig. 3).

(1) Symbol representing the kind of tolerance (Fig. 1, Fig. 2, and Fig. 3).

(2) Tolerance value (Fig. 1, Fig. 2, and Fig. 3).

(3) Letter symbol indicating the datum (Fig. 2 and Fig. 3).

In this case, where the feature to be controlled is a single feature, no letter symbol shall be attached (Fig. 1).

Remark: For the sequence of writing the datum indicating letter symbol in the case where there are multiple datums, refer to 8.3 (3) and (4).

Fig. 1

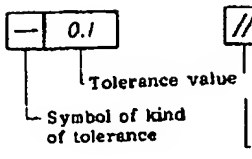


Fig. 2

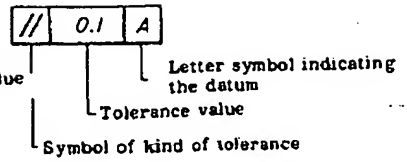
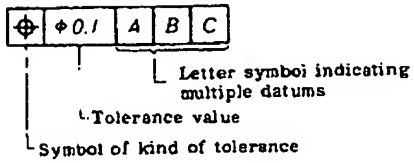


Fig. 3



6.2.2 Notes for specifying certain conditions in relation to a toleranced feature, such as "6 pieces" or "4 surfaces", shall be written above the tolerance frame (Fig. 4).

6.2.3 Where it is necessary to specify two or more kinds of tolerances for one feature, tolerance frames for those tolerances shall be put one under the other and the relevant contents shall be written in them respectively (Fig. 5).

Fig. 4

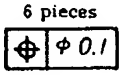
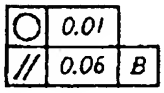


Fig. 5



6.3 Method of Indicating Features Controlled by Tolerances A feature controlled by a tolerance shall be indicated by connecting the tolerance frame to the considered feature with a leader line drawn from the tolerance frame and attached with an arrow mark at the end, according to the following requirements.

In this case, a thin solid line shall be used for the leader line.

(1) Where a tolerance is specified for a line or surface itself, the arrow mark of the leader line shall be applied perpendicularly on the outline of the feature or on an extension of the outline (but clearly apart from the position of the dimension line) (Fig. 6 and Fig. 7). However, this shall not apply in the case of 7.3.

Fig. 6

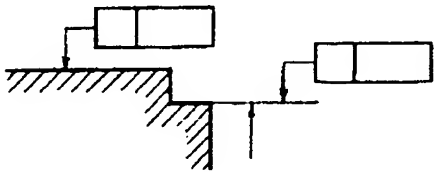
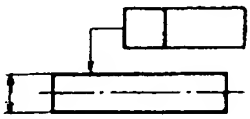


Fig. 7



(2) Where a tolerance is specified for the axis or median surface of a feature having a specified dimension, the arrow mark of the leader line shall be applied so that the extension of the dimension line agrees with the leader line from the tolerance frame (Fig. 8, Fig. 9, and Fig. 10).

Fig. 8

Fig. 9

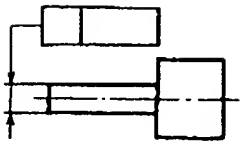
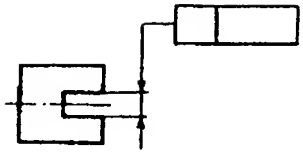


Fig. 10



(3) Where a tolerance is specified for the axes or median surfaces of all the features having a common axis or median plane, the arrow of the leader line from the tolerance frame shall be applied perpendicularly to the centre line which represents the common axis or median plane (Fig. 11, Fig. 12, and Fig. 13).

Fig. 11

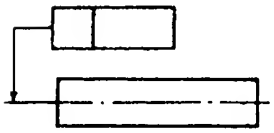


Fig. 12

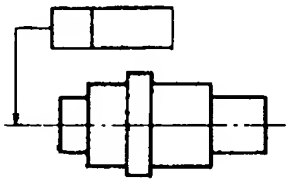
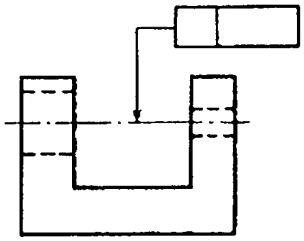


Fig. 13



(4) Where the same tolerance is specified for several separate features, the leader line drawn from a common tolerance frame may be branched (²) and applied to the individual features (Fig. 14), or the individual features may be indicated by their letter symbols (Fig. 15), instead of specifying the tolerance for those features respectively by using separate tolerance frames.

Note (²) A black dot shall be attached to the branching point of the leader line.

Fig. 14

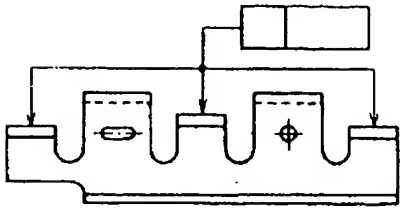
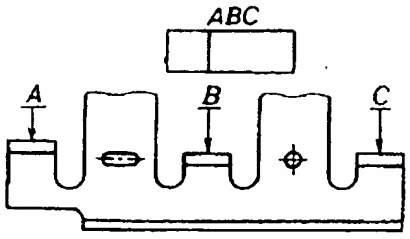


Fig. 15

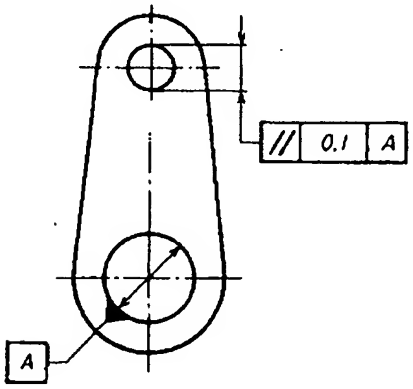


7. Relations between Method of Diagrammatical Indication and Tolerance Zone

7.1 Where symbol ϕ is absent before the tolerance value, the tolerance zone shall be treated with the understanding that the tolerance zone is present in the direction of the arrow of the leader line which connects the tolerance frame and the toleranced feature (Fig. 16). Where symbol ϕ is attached, the tolerance zone shall be treated as being present within a circle or cylinder (Fig. 17).

Fig. 16

(a) Example of Diagrammatical Indication



(b) Tolerance Zone in the Case of (a)

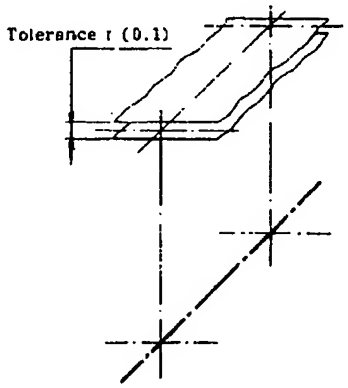
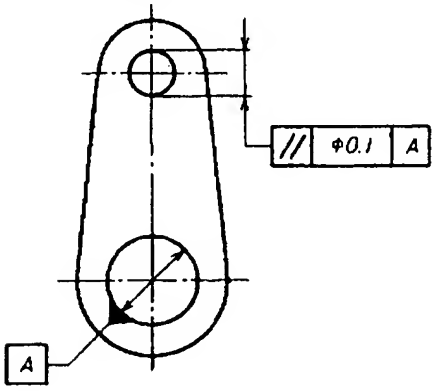
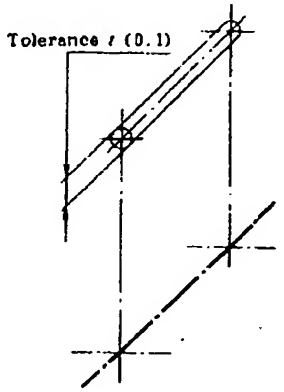


Fig. 17

(a) Example of Diagrammatical Indication



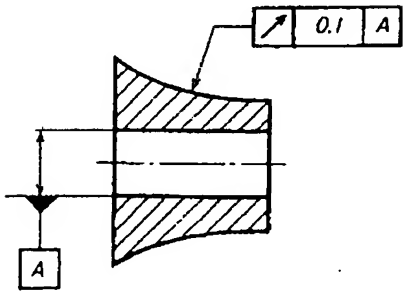
(b) Tolerance Zone in the Case of (a)



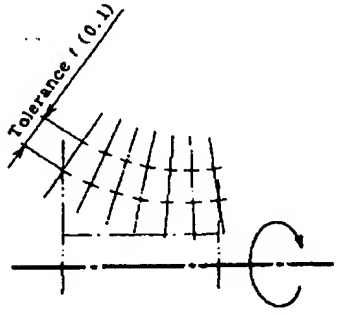
7.2 As a rule, the width of a tolerance zone shall be treated as being present in the direction normal to the controlled surface (Fig. 18).

Fig. 18

(a) Example of Diagrammatical Indication



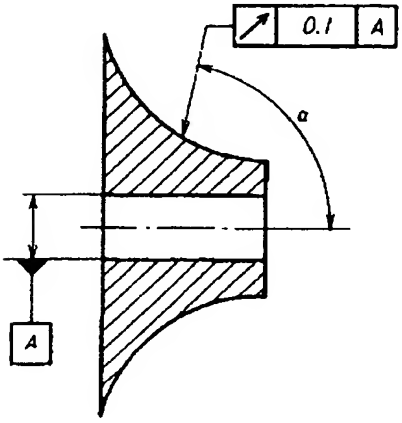
(b) Direction of Tolerance Zone in the Case of (a)



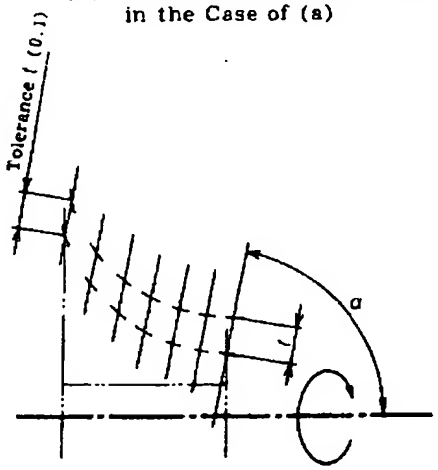
7.3 Where it is desired to specify a tolerance zone not in the direction normal to the surface but in other specific direction, that direction shall be specified (Fig. 19).

Fig. 19

(a) Example of Diagrammatical Indication



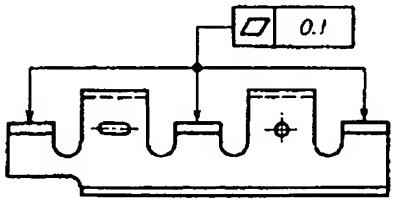
(b) Direction of Tolerance Zone in the Case of (a)



7.4 Where the same tolerance is specified for several separate features by using a common tolerance frame, unless otherwise specified, the tolerance zones specified for the respective features shall be applied (Fig. 20 and Fig. 21).

Fig. 20

(a) Example of Diagrammatical Indication



(b) Tolerance Zones in the Case of (a)

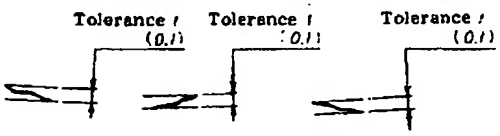
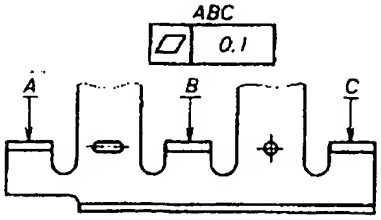
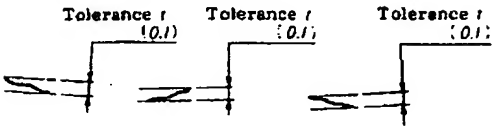


Fig. 21

(a) Example of Diagrammatical Indication



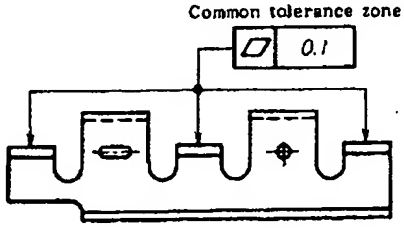
(b) Tolerance Zones in the Case of (a)



7.5 Where a tolerance value having a common zone is specified for several separate features, the letters "common tolerance zone" shall be written above the common tolerance frame (Fig. 22 and Fig. 23).

Fig. 22

(a) Example of Diagrammatical Indication



(b) Tolerance Zone in the Case of (a)

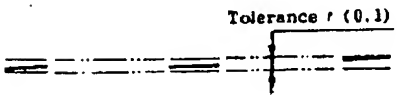
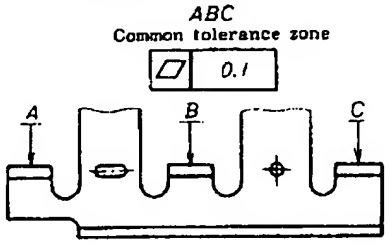
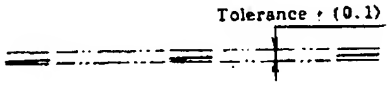


Fig. 23

(a) Example of Diagrammatical Indication



(b) Tolerance Zone in the Case of (a)



8. Method of Diagrammatical Indication of Datum

8.1 Where a tolerance specified for a feature is related to a datum, the datum shall be indicated by a letter symbol which specifies the datum, as a rule.

The datum shall be indicated by connecting with a leader line an English capital letter enclosed in a square frame and a datum triangle which indicates that it is the datum. The datum triangle may be smeared or not smeared (Fig. 24 and Fig. 25).

Fig. 24

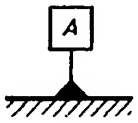
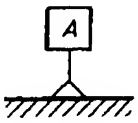


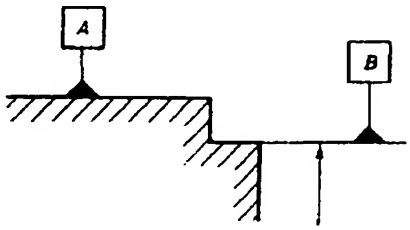
Fig. 25



8.2 The method of indication of a datum by a letter which specifies the datum shall be as follows:

(1) Where the datum feature is represented by a line or surface itself, a datum triangle shall be attached on the outline of the feature or on a thin line extending from the outline (but clearly apart from the position of the dimension line) (Fig. 26).

Fig. 26



(2) Where the datum is represented by the axial straight line or median plane of a feature with a specified dimension, indication shall be made by using an extension of the dimension line as the leader line of the datum [Fig. 27 (a) and (b), and Fig. 28].

Remark: Where the arrows of the dimension line are applied from the outside of supplementary dimension lines or outlines, one of the arrows shall be substituted with the datum triangle (Fig. 28 and Fig. 29).

Fig. 27

(a) (b)

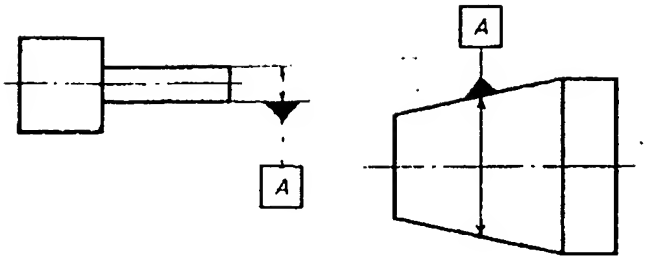
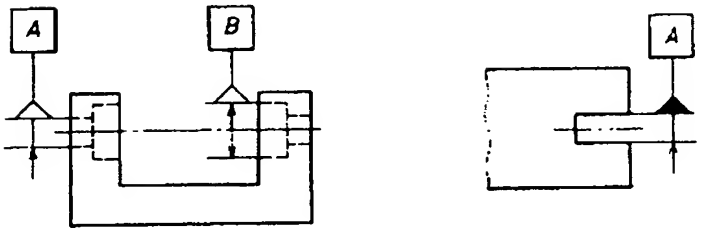


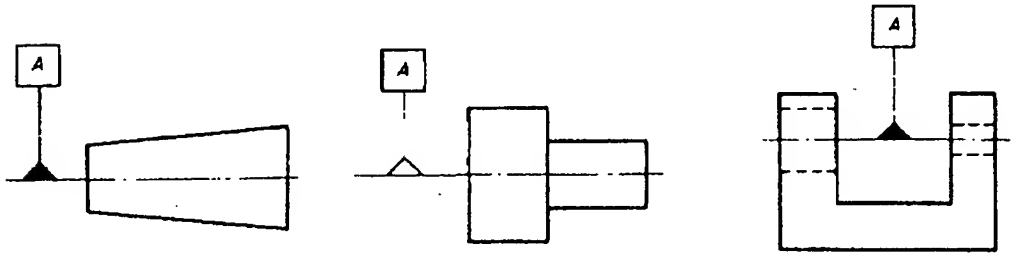
Fig. 28 Fig. 29



(3) Where the common axial straight line or median plane of all the features having a common axial straight line or median plane is the datum, a datum triangle shall be attached on the common axial straight line or the centre line representing the median plane (Fig. 30, Fig. 31, and Fig. 32).

Remark: Where three or more different features continue, it is desirable to avoid specifying their common axial straight line as the datum.

Fig. 30 Fig. 31 Fig. 32



(4) In the case where it is not liable to be failed to recognize, the letter symbol specifying the datum may be omitted by directly connecting the tolerance frame and the datum triangle (Fig. 33 and Fig. 34).

Fig. 33

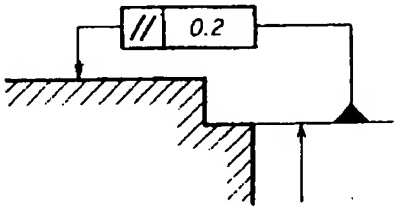
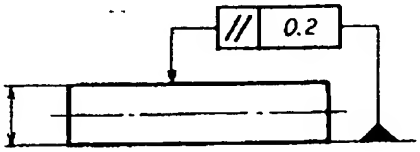


Fig. 34



8.3 The letter symbol specifying a datum shall be written in the tolerance frame by the following methods:

(1) A datum defined by one feature shall be indicated by one letter symbol which specifies that datum (Fig. 35).

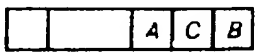
Fig. 35

(2) A common datum defined by two datum features shall be indicated by a symbol consisting of two letter symbols connected with a hyphen which specify the datum (Fig. 36).

Fig. 36

(3) Where there are two or more datums and the sequence is given to those datums, the letter symbols indicating the datums shall be written in separate compartments from left to right in the order of sequence (Fig. 37).

Fig. 37



(4) Where there are two or more datums and no order of sequence is given to those datums, the letter symbols indicating the datums shall be written side by side in the same compartment (Fig. 38).

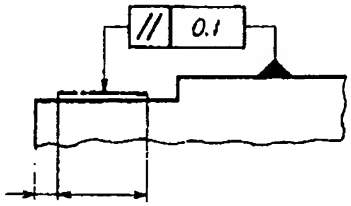
Fig. 38

9. Limitation of Application of Tolerance

9.1 Where it is desired to apply a tolerance value only to a limited range of a line or surface, it shall be diagrammatically indicated by showing the limited range by a thick alternate long and short dash line drawn along the line or surface ([3]) (Fig. 39).

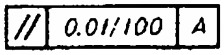
Note ([3]) See 4. in JIS B 0001.

Fig. 39



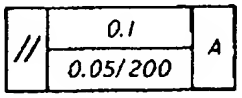
9.2 Where a tolerance is specified with respect to a specific length at any position of the considered feature, an oblique line shall be drawn after the tolerance value and the specific length shall be written thereafter (Fig. 40).

Fig. 40



9.3 Where a tolerance value for the whole range of the considered feature and a tolerance value for a certain specific length of the feature are specified at the same time, the former value shall be written above the latter value with a lateral dividing line between them (Fig. 41).

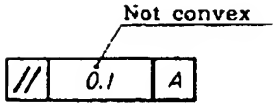
Fig. 41



9.4 Where it is desired to particularly specify the character of the feature within the tolerance zone, the character requirements shall be written in the vicinity of the tolerance frame, otherwise the written requirements shall be connected to the tolerance value with a leader line (Fig. 42 and Fig. 43).

Fig. 42

Fig. 43



10. Method of Diagrammatical Indication of Theoretically Exact Dimension

Where a tolerance of location, profile, or angularity is specified for a feature, the dimension which specifies the theoretically exact location, profile, or angle shall be shown by enclosing with a rectangular frame as [30] (Fig. 44 and Fig. 45).

Remark: A dimension shown in such a rectangular frame is termed the theoretically exact dimension and it has no dimensional tolerance in itself.

Fig. 44

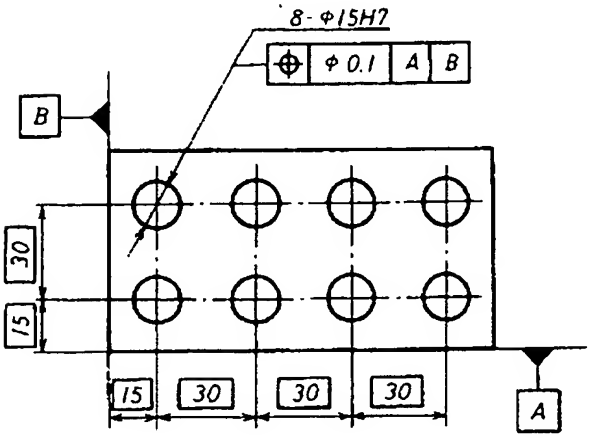
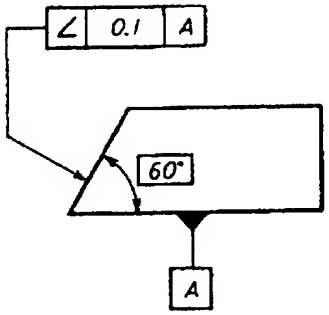


Fig. 45

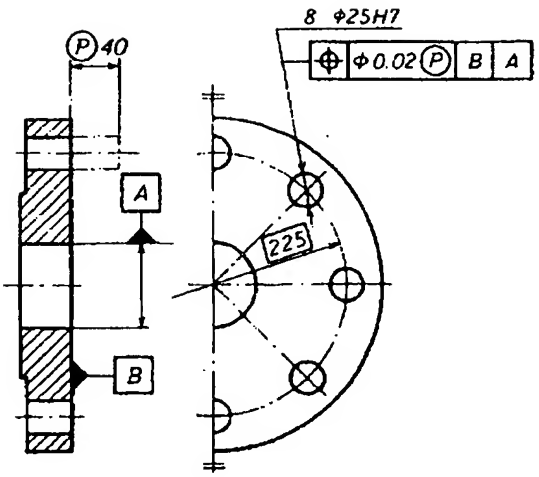


11. Method of Indicating Projected Tolerance Zone

Where it is desired to specify a tolerance zone not within but outside of the feature itself, that projected part shall be shown by a thin alternate long and two short dashes line and the symbol Ⓟ shall be written before the dimension figures and also after the tolerance value (Fig. 46).

Remark: A tolerance zone defined by such indication is termed a projected tolerance zone and this may be applicable to orientation tolerance and location tolerance.

Fig. 46



12. Method of Indicating Application of Maximum Material Principle

12.1 To indicate the application of the maximum material principle, the indications shall be made respectively by the following methods by using the symbol Ⓜ according to whether the maximum material principle is applied to the toleranced feature, to the datum feature, or to both of them.

(1) Where the principle is applied to the toleranced feature, Ⓜ shall be written after the tolerance value (Fig. 47).

(2) Where the principle is applied to the datum feature, Ⓜ shall be written after the letter symbol indicating the datum (Fig. 48).

(3) Where the principle is applied to both the toleranced feature and its datum feature, Ⓜ shall be written after the tolerance value and after the letter symbol indicating the datum (Fig. 49).

Fig. 47

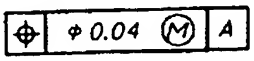


Fig. 48

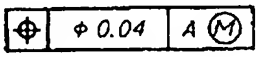
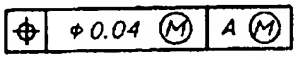


Fig. 49



12.2 To indicate the application of the maximum material principle in the case where the datum is not shown by the letter symbol indicating the datum, symbol Ⓜ shall be written in the third compartment of the tolerance frame (Fig. 50 and Fig. 51).

Remark: The application of the maximum material principle shall be based on JIS B 0023.

Fig. 50

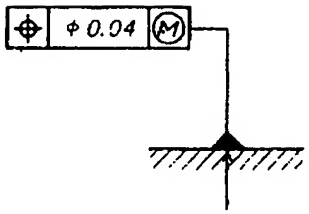
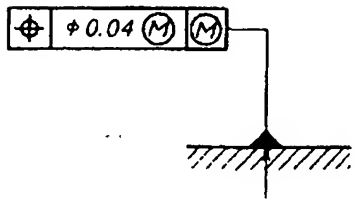


Fig. 51



13. Definition of Tolerance Zone, Examples of Diagrammatical Indication, and Interpretation

The definitions of tolerance zones of geometrical tolerances, examples of diagrammatical indication, and their interpretations are shown in Attached Table.

Remarks 1. The Attached Table shows the definitions of tolerance zones of geometrical tolerances, representative examples of diagrammatical indications with their interpretations, and explanatory drawings.

In the Attached Table, the explanatory drawings are shown only with respect to the deviations dealt with by the relevant tolerances.

2. The tolerance zones of straightness of lines or axes with respect to only one direction are shown in the explanatory drawings by either of the following methods:

(1) By two parallel planes apart from each other by a distance of tolerance t (Fig. 52).

(2) By two parallel straight lines apart from each other by a distance of tolerance t (Fig. 53).

Fig. 52

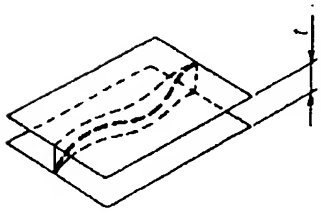


Fig. 53

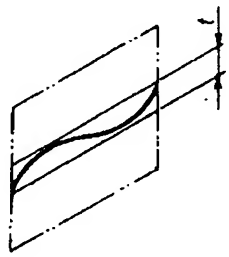


Fig. 52 has been prepared by the three-dimensional diagramming method, and Fig. 53 is its projection on a plane. There is no difference in meaning of the two representations. The explanatory drawings of tolerance zones in Attached Table have been selected to make the meaning of explanation as understandable as possible.

3. Those dimension lines attached with φ in the examples of diagrammatical indication in Attached Table show that the considered features are circles or cylinders.

Attached Table. Definitions of Tolerance Zones of Geometrical Tolerances and Examples of Diagrammatical Indication and Interpretations Thereof

Lines used in the drawings in the column of "definition of tolerance zone" indicate the following meanings:

Thick solid line or broken line: Feature

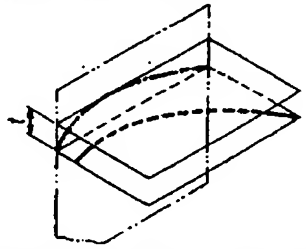
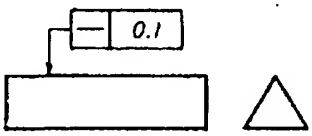
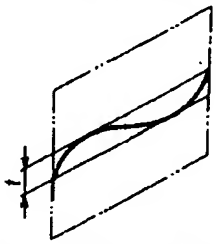
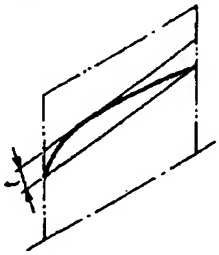
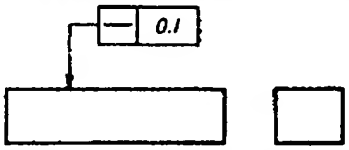
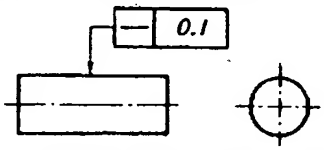
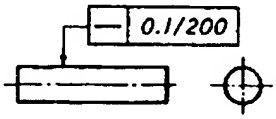
Thick alternate long and short dash line: Datum

Thin solid line or broken line: Tolerance zone

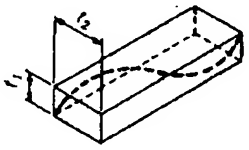
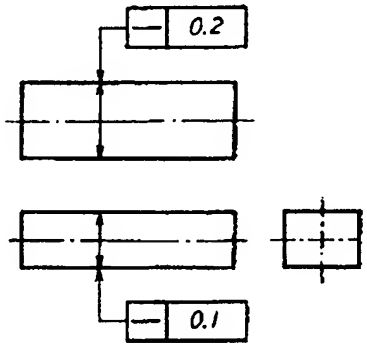
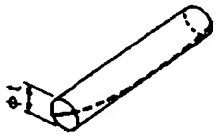
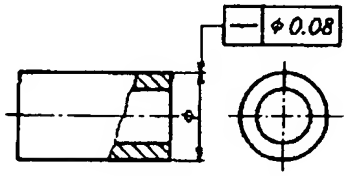
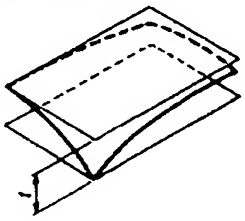
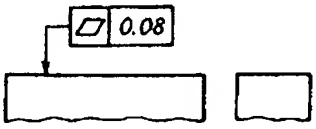
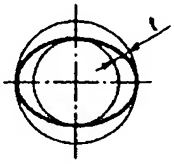
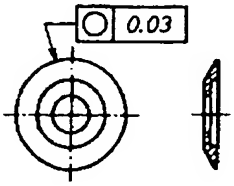
Thin alternate long and short dash line: Centre line

Thin alternate long and two short dashes line: Supplementary projection plane or sectional plane

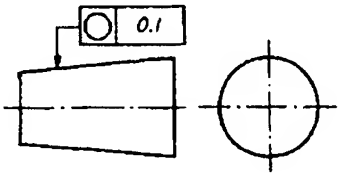
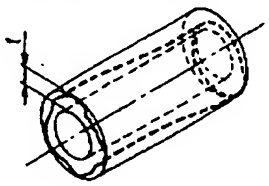
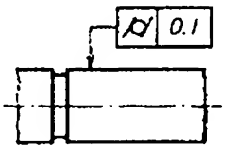
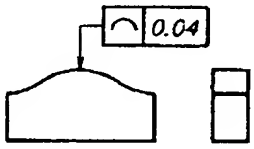
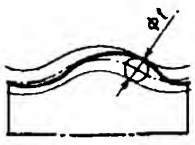
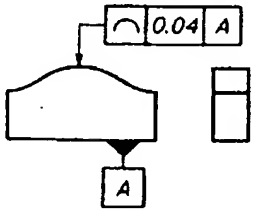
Thick alternate long and two short dashes line: Projection of a feature to supplementary projection plane or sectional plane

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
1. Straightness Tolerance	
1.1 Straightness tolerance of line	
The tolerance zone, when projected on a plane, is a zone held between two parallel straight lines a distance t apart from each other. 	The straight line indicated by the arrow of the leader line shall be contained between two parallel planes 0.1 mm apart in the direction of the arrow. 
1.2 Straightness tolerance of line as an element of surface	
The tolerance zone is a zone held between two parallel straight lines a distance t apart in a sectional plane in the specified direction.  Particularly, in a feature of an object symmetric about an axis, the tolerance zone is a zone on a plane containing the axis of symmetry. 	When the surface shown by the arrow of the leader line is cut by any plane parallel to the projection plane of the figure having a tolerance frame, the line appearing on the sectional plane shall be contained between two parallel straight lines 0.1 mm apart in the direction of the arrow.  Any generator on the cylinder surface shown by the arrow of the leader line shall be contained between two parallel straight lines 0.1 mm apart in the plane containing the cylinder axis.  Any part of 200 mm length of any generator of the cylinder surface shown by the arrow of the leader line shall be contained between two parallel straight lines 0.1 mm apart in the plane containing the axis. 

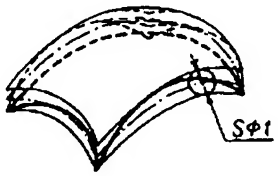
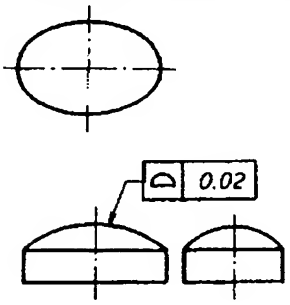
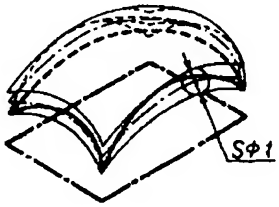
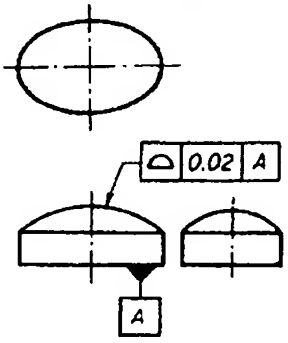
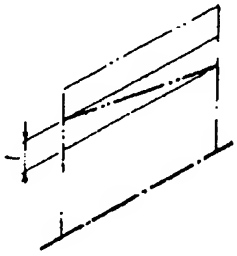
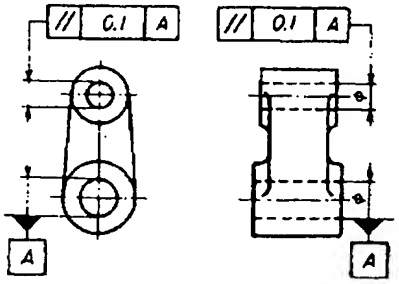
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
1. Straightness Tolerance (continued)	
1.3 Straightness tolerance of axis	
Where a tolerance zone is specified in two directions perpendicular to each other, this tolerance zone is a zone in a rectangular parallelepiped of section $t_1 \times t_2$. 	The axis of this square bar shall be contained in a rectangular parallelepiped respectively 0.1 mm and 0.2 mm in width in the directions shown by the arrows of the leader lines. 
Where symbol ϕ is attached before the numerical value indicating a tolerance zone, this tolerance zone is a zone in a cylinder of diameter t. 	Where a tolerance frame is connected to the dimension showing the diameter of a cylinder, the axis of the cylinder shall be contained in a cylinder of 0.08 mm diameter. 
2. Flatness Tolerance	
The tolerance zone is a zone held between two parallel planes a distance t apart. 	This surface shall be contained between two parallel planes 0.08 mm apart. 
3. Circularity Tolerance	
The tolerance zone in the considered plane is a zone between two concentric circles a distance t apart. 	The circumference in any cross-section normal to the axis of the outside cylindrical surface shall be contained between two concentric circles 0.03 mm apart on the same plane. 

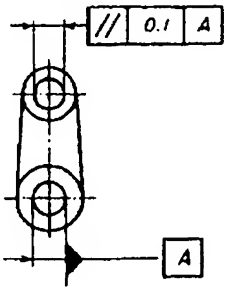
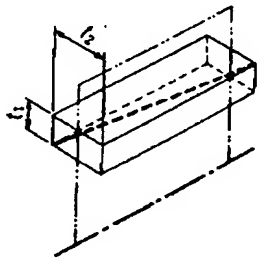
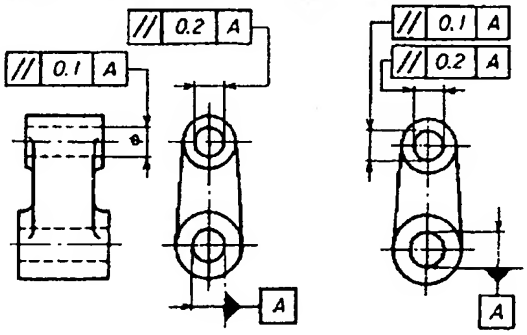
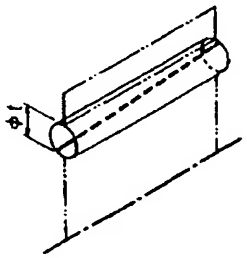
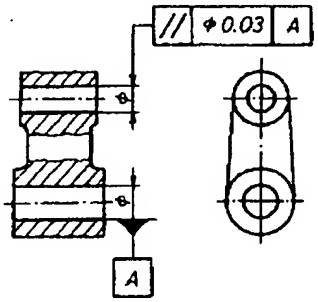
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
3. Circularity Tolerance (continued)	
	The circumference in any section normal to the axis shall be contained between two concentric circles 0.1 mm apart on the same plane. 
4. Cylindricity Tolerance	
The tolerance zone is a zone contained between two coaxial cylinder surfaces a distance t apart. 	The considered surface shall be contained between two coaxial cylinder surfaces 0.1 mm apart. 
5. Profile Tolerance of Line	
5.1 Profile tolerance of line of single feature	
The tolerance zone is a zone held between two lines enveloping circles of diameter t, the centers of which are situated on a theoretically exact profile line. 	In any cross-section parallel to the projection plane, the considered profile shall be contained between two lines enveloping circles of 0.04 mm in diameter, the centres of which are situated on a line having the theoretically exact profile. 
5.2 Profile tolerance of line of related feature	
The tolerance zone, in relation to the datum, is a zone held between two lines enveloping circles of diameter t, the centres of which are situated on the theoretically exact profile line. 	In any cross-section parallel to the projection plane, the considered profile shall be, in relation to datum plane A, between two lines enveloping the circles of diameter 0.04 mm, the centres of which are situated on a line having the theoretically exact profile. 

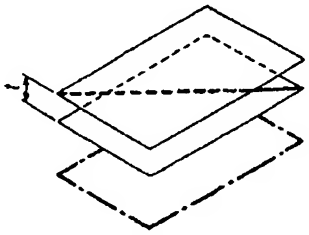
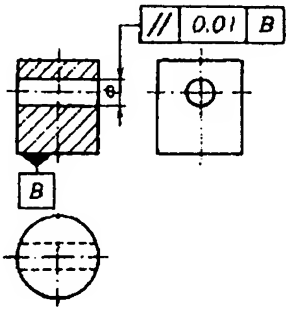
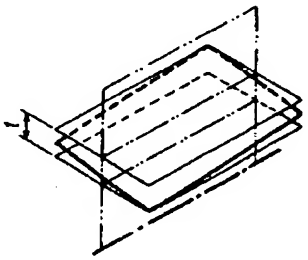
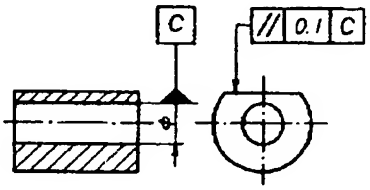
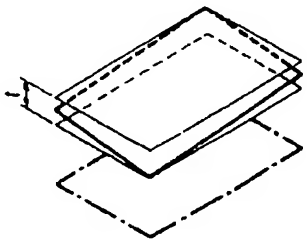
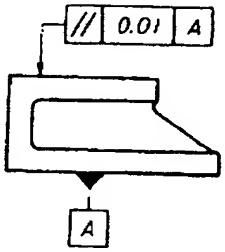
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
6. Profile Tolerance of Surface	
6.1 Profile tolerance of surface of single feature	
The tolerance zone is a zone held between the two surfaces enveloping the spheres of diameter t, the centres of which are situated on a theoretically exact profile surface. 	The considered surface shall be contained between two surfaces enveloping the spheres of diameter 0.02 mm, the centres of which are situated on a surface having the theoretically exact profile. 
6.2 Profile tolerance of surface of related feature	
The tolerance zone, in relation to the datum, is a zone held between the two surfaces enveloping the spheres of diameter t, the centres of which are situated on a theoretically exact profile surface. 	The considered surface in relation to the datum A, shall be contained between two surfaces enveloping the spheres of diameter 0.02 mm, the centres of which are situated on a surface having the theoretically exact profile. 
7. Parallelism Tolerance	
7.1 Parallelism tolerance of a line with reference to a datum straight line	
The tolerance zone, when projected on a plane, is a zone held between the two parallel straight lines parallel to the datum straight line and a distance t apart from each other. 	The axis shown by the arrow of the leader line shall be contained between two planes 0.1 mm apart from each other which are parallel to the datum axial straight line A and are situated in the direction of the arrow of the leader line (vertical direction). 

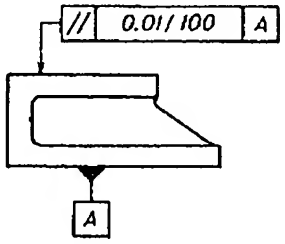
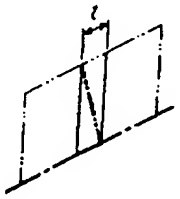
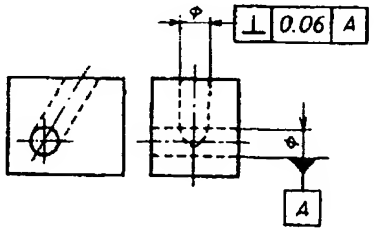
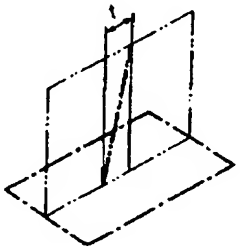
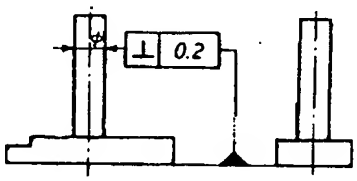
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
7. Parallelism Tolerance (continued)	
7.1 Parallelism tolerance of a line with reference to a datum straight line (continued)	
	The axis shown by the arrow of the leader line shall be contained between two planes 0.1 mm apart from each other and situated in the direction of the arrow of the leader line (horizontal direction). 
Where the tolerance is specified in two planes perpendicular to each other, the tolerance zone is the zone in a rectangular parallelepiped of section $t_1 \times t_2$ parallel to the datum straight line. 	The axis shown by the arrow of the leader lines shall be contained in a rectangular parallelepiped which has a width in each direction of the arrow of the leader line, that is, a width of 0.2 mm in the horizontal direction and 0.1 mm in the vertical direction, and which is parallel to the datum axial straight line A. 
Where symbol ϕ is attached before the numerical value indicating the tolerance, the tolerance zone is the zone within a cylinder of diameter ϕt parallel to the datum straight line. 	The axis shown by the arrow of the leader line shall be contained in a cylinder of 0.03 mm in diameter parallel to the datum axial straight line A. 

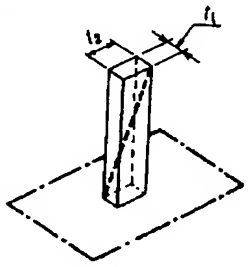
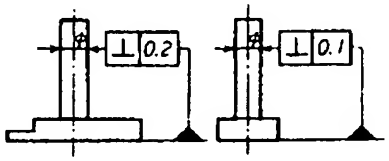
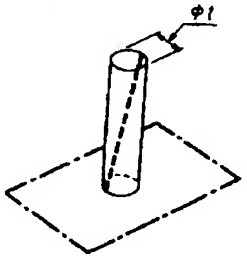
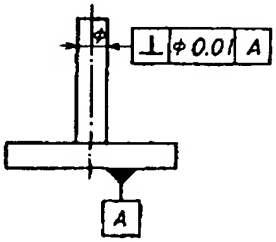
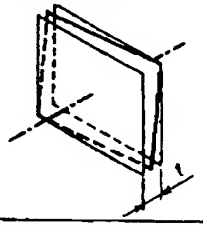
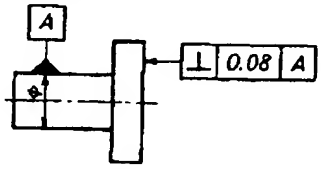
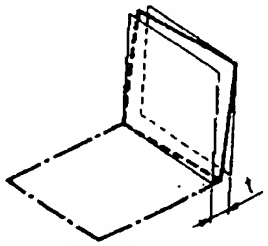
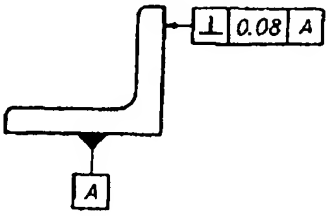
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
7. Parallelism Tolerance (continued)	
7.2 Parallelism tolerance of a line with reference to a datum plane	
The tolerance zone is a zone held between two parallel planes parallel to the datum plane and a distance t apart from each other. 	The axis shown by the arrow of the leader line shall be contained between two planes parallel to the datum plane B and 0.01 mm apart from each other in the direction of the arrow of the leader line. 
7.3 Parallelism tolerance of a surface with reference to a datum straight line	
The tolerance zone is a zone held between two parallel planes parallel to the datum straight line and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two planes parallel to the datum axial straight line C and 0.1 mm apart from each other in the direction of the arrow of the leader line. 
7.4 Parallelism tolerance of a surface with reference to a datum plane	
The tolerance zone is a zone held between two parallel planes parallel to the datum plane and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two planes parallel to the datum plane A and 0.01 mm apart from each other in the direction of the arrow of the leader line. 

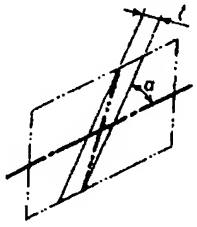
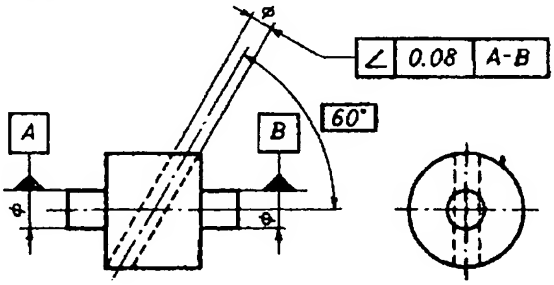
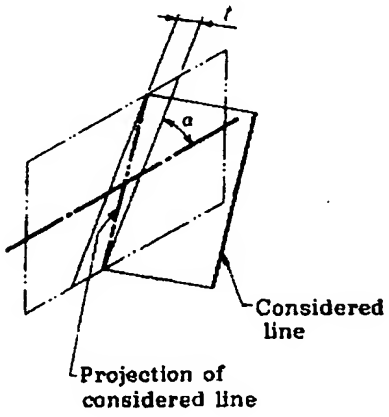
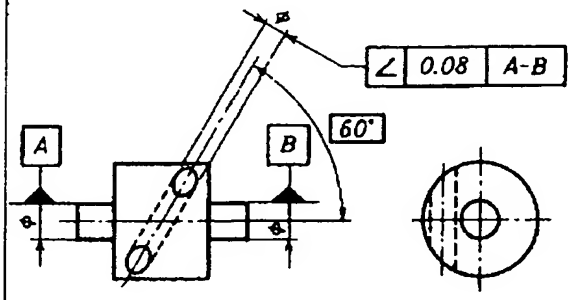
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
7. Parallelism Tolerance (continued)	
7.4 Parallelism tolerance of a surface with reference to a datum plane (continued)	
	On the surface shown by the arrow of the leader line, all the points on any 100 mm length shall be contained between two planes parallel to the datum plane A and 0.01 mm apart from each other in the direction of the arrow of the leader line. 
8. Perpendicularity Tolerance	
8.1 Perpendicularity tolerance of a line with reference to a datum straight line	
The tolerance zone, when projected on a plane, is a zone held between two parallel straight lines perpendicular to the datum straight line and a distance t apart from each other. 	The axis of the inclined hole shown by the arrow of the leader line shall be contained between two parallel planes perpendicular to the datum axial straight line A and 0.06 mm apart from each other in the direction of the arrow of the leader line. 
8.2 Perpendicularity tolerance of a line with reference to a datum plane	
Where the tolerance is specified only in one direction, the tolerance zone projected on a plane is a zone held between two parallel straight lines perpendicular to the datum plane and a distance t apart from each other. 	The axis of the cylinder shown by the arrow of the leader line shall be contained between two parallel planes perpendicular to the datum plane and 0.2 mm apart from each other in the direction of the arrow of the leader line. 

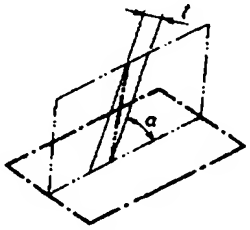
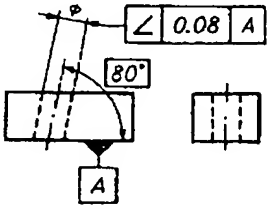
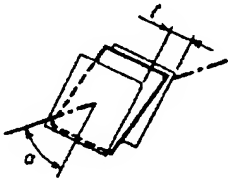
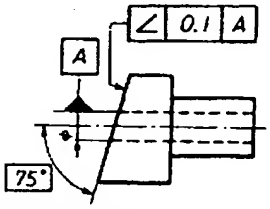
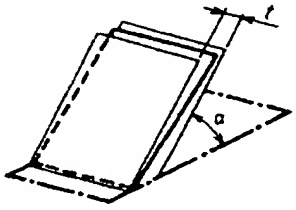
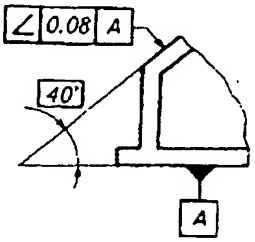
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
8. Perpendicularity Tolerance (continued)	
8.2 Perpendicularity tolerance of a line with reference to a datum plane (continued)	
Where the tolerance is specified in two directions perpendicular to each other, the tolerance zone is a zone within a rectangular parallelepiped of section $t_1 \times t_2$ perpendicular to the datum plane. 	The axis of the cylinder shown by the arrows of the leader lines shall be contained within a rectangular parallelepiped 0.2 mm and 0.1 mm in width respectively in the directions of the arrows of the leader lines and perpendicular to the datum plane. 
Where symbol ϕ is attached before the numerical value indicating the tolerance, the tolerance zone is a zone within a cylinder of diameter t perpendicular to the datum plane. 	The axis of the cylinder shown by the arrow of the leader line shall be contained within a cylinder of diameter 0.01 mm perpendicular to the datum plane A. 
8.3 Perpendicularity tolerance of a surface with reference to a datum straight line	
The tolerance zone is a zone held between two parallel planes perpendicular to the datum straight line and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two parallel planes perpendicular to the datum axial straight line A and 0.08 mm apart from each other in the direction of the arrow of the leader line. 
8.4 Perpendicularity of a surface with reference to a datum plane	
The tolerance zone is a zone held between two parallel planes perpendicular to the datum plane and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two parallel planes perpendicular to the datum plane A and 0.08 mm apart from each other in the direction of the arrow of the leader line. 

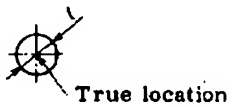
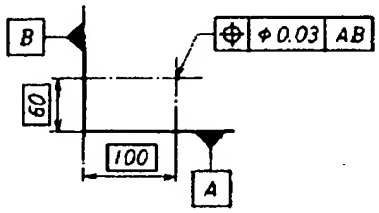
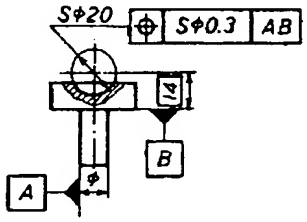
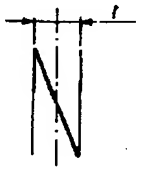
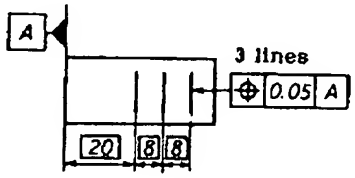
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
9. Angularity Tolerance	
9.1 Angularity tolerance of a line with reference to a datum straight line	
(a) Line and Datum Straight Line on the Same Plane The tolerance zone when projected on a plane is a zone held between two parallel straight lines being inclined at the specified angle to the datum straight line and a distance t apart from each other. 	The axis of the hole shown by the arrow of the leader line shall be contained between two parallel planes which are inclined at 60° with theoretical exactness to the datum axial straight line A-B and which are 0.08 mm apart from each other in the direction of the arrow of the leader line. 
(b) Line and Datum Straight Line on Different Planes Where the considered line and the datum straight line are not on the same plane, the tolerance zone is a zone held between two parallel straight lines being inclined at the specified angle to the datum straight line and a distance t apart from each other, if the considered line is projected on a plane which contains the datum straight line and parallels to the considered line. 	The projection of the axis of the hole in the plane containing the datum axial straight line A-B and parallel to the axis of the hole shown by the arrow of the leader line shall be contained between two parallel straight lines which are inclined at 60° with theoretical exactness to the datum axial straight line A-B and which are 0.08 mm apart from each other in the direction of the arrow of the leader line. 

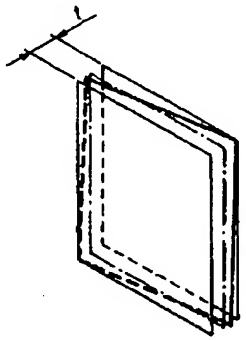
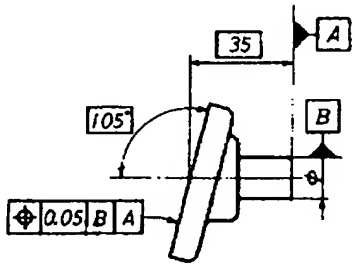
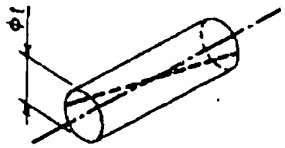
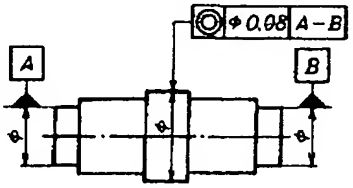
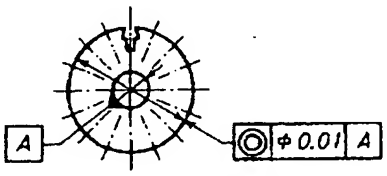
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
9. Angularity Tolerance (continued)	
9.2 Angularity tolerance of a line with reference to a datum plane	
The tolerance zone projected on a plane is a zone held between two parallel straight lines inclined at the specified angle to the datum plane and a distance t apart from each other. 	The axis of the cylinder shown by the arrow of the leader line shall be held between two parallel planes which are inclined at 80° with theoretical exactness to the datum plane and which are 0.08 mm apart from each other in the direction of the arrow of the leader line. 
9.3 Angularity tolerance of a surface with reference to a datum straight line	
The tolerance zone is a zone held between two parallel planes inclined at the specified angle to the datum straight line and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two parallel planes which are inclined at 75° with theoretical exactness to the datum axial straight line A and which are 0.1 mm apart from each other in the direction of the arrow of the leader line. 
9.4 Angularity tolerance of a surface with reference to a datum plane	
The tolerance zone is a zone held between two parallel planes inclined at the specified angle to the datum plane and a distance t apart from each other. 	The surface shown by the arrow of the leader line shall be contained between two parallel planes which are inclined at 40° with theoretical exactness to the datum plane A and which are 0.08 mm apart from each other in the direction of the arrow of the leader line. 

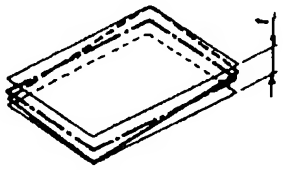
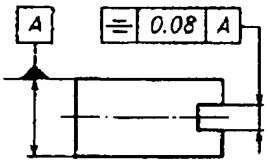
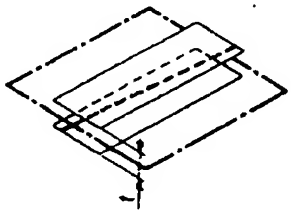
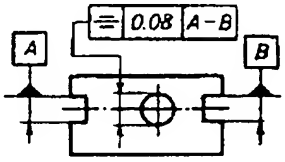
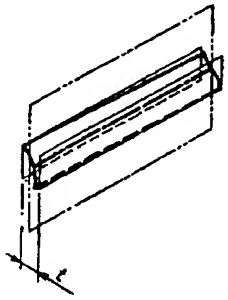
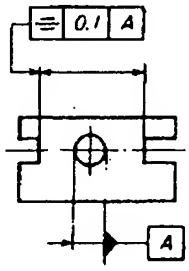
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
10. Positional Tolerance	
10.1 Positional tolerance of a point	
The tolerance zone is a zone within a circle or sphere of diameter t having its centre at the theoretically exact location, hereinafter referred to as the "true location".   	The point shown by the arrow of the leader line shall be contained within a circle of 0.03 mm diameter having its centre at the true location 60 mm and 100 mm apart, respectively, from the datum straight line A and from the datum straight line B. In the case of this example of diagrammatical indication, the sequence about the datum straight lines A and B is not considered.  Remark: Where the thickness in the direction normal to the surface appearing in this drawing is taken into consideration, the circle explained here becomes a cylinder, and the point becomes a line. The centre of the sphere shown by the arrow of the leader line shall be contained within a sphere of diameter 0.3 mm having its centre at the true location 14 mm apart from the datum plane B on the datum axial straight line A. 
10.2 Positional tolerance of a line	
The positional tolerance zone of a line where the tolerance is specified only in one direction is a zone defined by two parallel straight lines or two parallel planes arranged symmetrically about the true location and a distance t apart from each other.  	The respective lines shown by the arrow of the leader line shall be contained between two parallel straight lines which are arranged symmetrically about the straight lines specified as the true locations of those straight lines and which are 0.05 mm apart from each other. 

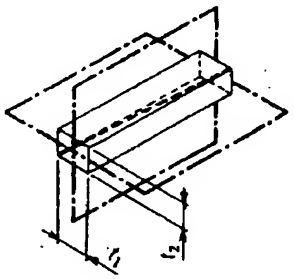
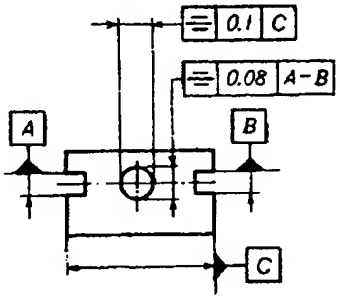
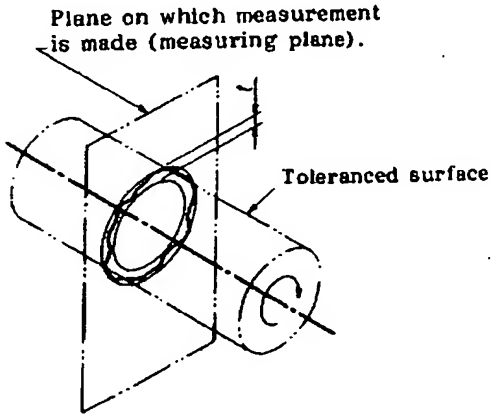
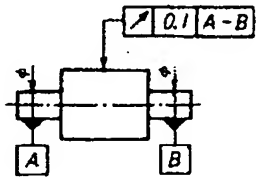
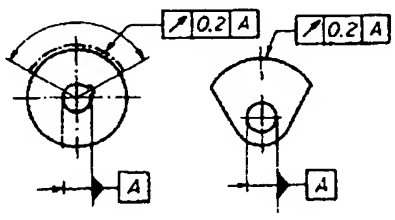
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
10. Positional Tolerance (continued)	
10.3 Positional tolerance of a surface	
The tolerance zone is a zone held between two parallel planes a distance t apart from each other and arranged symmetrically about the true location of the considered surface. 	The plane shown by the arrow of the leader line shall be contained between two parallel planes 0.05 mm apart from each other and arranged symmetrically in the direction of the arrow of the leader line about the true location which is inclined at 105° to the datum axial straight line B at a position 35 mm apart from the datum plane A on the datum axial straight line B. 
11. Coaxiality Tolerance or Concentricity Tolerance	
11.1 Coaxiality tolerance	
Where symbol ϕ is attached before the numerical value indicating the tolerance, the tolerance zone is a zone within a cylinder of diameter *t* whose axis agrees with the datum axial straight line. 	The axis shown by the arrow of the leader line shall be contained within a cylinder of 0.08 mm diameter whose axis agrees with the datum axial straight line A-B. 
11.2 Concentricity tolerance	
The tolerance zone is a zone within a circle of diameter *t* whose centre agrees with the datum point. 	The centre of the circle shown by the arrow of the leader line shall be contained within a circle of 0.01 mm diameter whose centre agrees with the datum point A. 

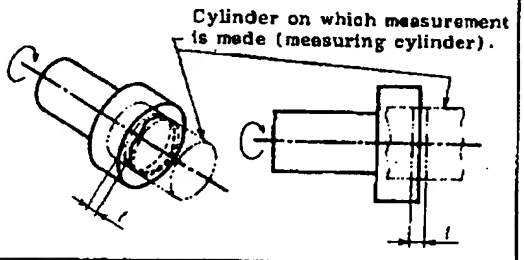
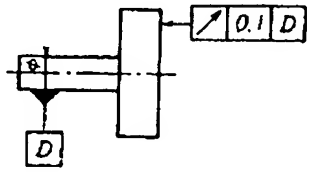
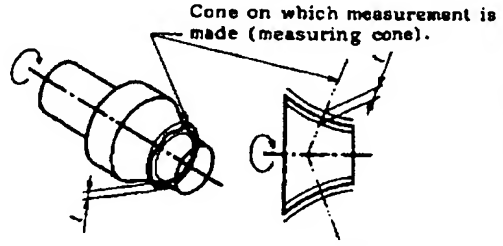
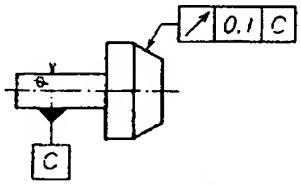
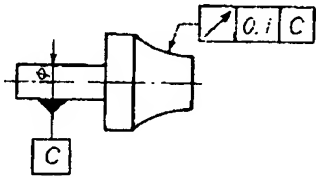
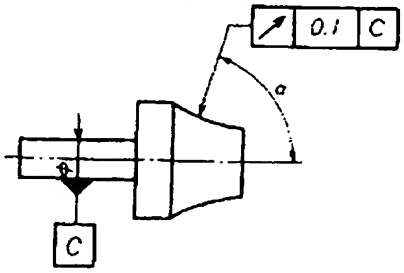
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
12. Symmetry Tolerance	
12.1 Symmetry tolerance of a surface with reference to a datum median plane	
The tolerance zone is a zone held between two parallel planes a distance t apart from each other and arranged symmetrically about the datum median plane. 	The median surface shown by the arrow of the leader line shall be contained between two parallel planes 0.08 mm apart from each other and arranged symmetrically about the datum median plane A. 
12.2 Symmetry tolerance of a line with reference to a datum median plane	
Where the tolerance is specified only in one direction, the tolerance zone is a zone held between two parallel planes arranged symmetrically about the datum median plane and a distance t apart from each other. 	The axis shown by the arrow of the leader line shall be contained between two parallel planes 0.08 mm apart from each other and are arranged symmetrically about the datum median plane A-B. 
12.3 Symmetricity tolerance of a surface with reference to datum straight line	
The tolerance zone is a zone held between two parallel planes a distance t apart from each other and arranged symmetrically about the datum straight line. 	The median plane shown by the arrow of the leader line shall be contained between two parallel planes 0.1 mm apart from each other and arranged symmetrically about the datum axial straight line A. 

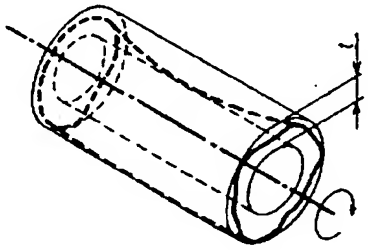
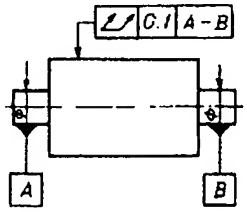
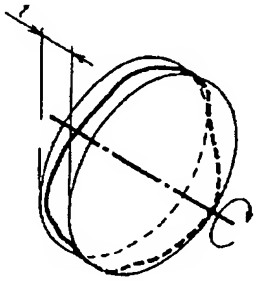
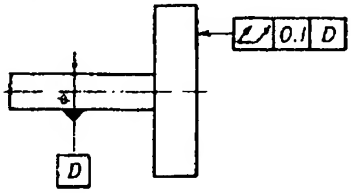
Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
12. Symmetry Tolerance (continued)	
12.4 Symmetry tolerance of a line with reference to a datum straight line	
Where the tolerance is specified in two directions perpendicular to each other, the tolerance zone is a zone in a rectangular parallelepiped of section $t_1 \times t_2$, the axis of which coincides with the datum straight line (for example, the intersection line of two datum planes). 	The axis shown by the arrow of the leader line shall be contained in a rectangular parallelepiped defined by two sets of two parallel planes. In this case, one set of those planes shall be 0.08 mm apart from each other and arranged symmetrically about the datum median plane A-B and the other set of those planes 0.1 mm apart from each other and symmetrically about the datum median plane C. 
13. Circular Run-Out Tolerance	
13.1 Circular run-out tolerance in radial direction	
The tolerance is a zone between two concentric circles whose centres agree with the datum axial straight line on any measuring plane normal to the datum axial straight line and which are a distance t apart from each other in the radial direction. Run-out tolerance is generally applied to one complete rotation around the axis, but could be limited to apply to a part of one rotation. 	The run-out in the radial direction of the cylinder surface shown by the arrow of the leader line shall not exceed 0.1 mm on any measuring plane normal to the datum axial straight line when the cylinder is rotated by one rotation about the datum axial straight line A-B.  The run-out in the radial direction of a part of the cylinder surface shown by the arrow of the leader line [the range shown by the thick alternate long and short dash line in Figure (a), and the fan-shaped part of the cylinder in Figure (b)] shall not exceed 0.2 mm on any measuring plane normal to the datum axial straight line when the toleranced feature part is rotated about the datum axial straight line A. (a) (b) 

Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
13. Cylindrical Run-Out Tolerance (continued)	
13.2 Circular run-out tolerance in axial direction	
The tolerance zone is a zone held between two circles which are situated on a measuring cylinder having an axis agreeing with the datum axial straight line at any location in the radial direction and which are a distance *t* apart from each other in the axial direction. 	The run-out in the axial direction of the side surface of the cylinder shown by the arrow of the leader line shall not exceed 0.1 mm on any measuring position (measuring cylinder surface) when the cylinder is subjected to one rotation about the datum axial straight line D. 
13.3 Circular run-out tolerance in normal direction to the feature, but obliquely to the datum axis	
The tolerance zone is a zone held between two circles which are on any measuring conical surface having an axis agreeing with the datum axial straight line and perpendicularly intersecting the toleranced feature surface and which are a distance *t* apart from each other along the surface.  Remark: This definition applies to cases where the measuring direction is not particularly specified by a leader line, and the measuring direction is normal to the surface.	The run-out of this conical surface in the direction shown by the arrow of the leader line shall not exceed 0.1 mm on any measuring conical surface when the cone is subjected to one rotation about the datum axial straight line C.  The run-out of this curved surface in the direction normal to the tangent lines at all positions on the curved surface, shall not exceed 0.1 mm on any measuring conical surface when the curved surface is subjected to one rotation about the datum axial straight line C. 
13.4 Circular run-out tolerance in specified direction	
The tolerance zone is a zone held between two circles which are on any measuring conical surface having an axis agreeing with the datum axial straight line and having the specified direction and which are a distance *t* apart from each other along the surface.	The run-out of this curved surface having a direction inclined at angle α to the datum axial straight line shall not exceed 0.1 mm on any measuring conical surface when the curved surface is subjected to one rotation about the datum axial straight line C. 

Attached Table (Continued)

Definition of tolerance zone	Examples of diagrammatical indication and its interpretation
14. Total Run-Out Tolerance	
14.1 Total radial run-out tolerance	
The tolerance zone is a zone between two coaxial cylinders having axes agreeing with the datum axial straight line and a distance t apart from each other in the radial direction. 	The total radial run-out of the cylinder surface shown by the arrow of the leader line shall not exceed 0.1 mm at any point on the cylinder surface when the cylinder part is rotated about the datum axial straight line A-B with a relative movement in the axial direction between this cylinder part and the measuring instrument. In this case, the relative movement of the measuring instrument or of the considered object shall be performed along a line having theoretically perfect form of the contour and being at correct position to the datum axial straight line. 
14.2 Total axial run-out tolerance	
The tolerance zone is a zone held between two parallel planes which are perpendicular to the datum axial straight line and a distant t apart from each other in the direction of the datum axial straight line. 	The total axial run-out of the cylinder side surface shown by the arrow of the leader line shall not exceed 0.1 mm at any point on the cylinder side surface when the cylinder side surface is rotated about the datum axial straight line D with a relative movement in the radial direction between this side surface and the measuring instrument. In this case, the relative movement of the measuring instrument or of the considered object shall be performed along a line having the theoretically perfect form of the contour and being at correct position to the datum axial straight line. 

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